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What Causes Legume Sickness? Page 3

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Strawberries on the Cake

Most consumers approach strawberry shortcake with gusto, not realizing that this treat was insured as a commonplace part of their diets by a treatment developed a decade ago in agricultural research.

That "treatment" took the form of virus-free strawberry varieties that were located through tedious screening by ARS scientists and the industry to find disease-free plants. The virus had put an exceedingly low ceiling on strawberry production—until the virus-free varieties were made available to growers.

A similar low ceiling has been hampering the raspberry industry, now plagued by two mosaic viruses that often reduce yields and stands 50 percent or more. But research like that with strawberries has now improved the outlook for raspberry production (pp. 8 and 9, this issue). ARS scientists not only have perfected a simple graft method of detecting mosaic virus, which is often hidden, but they are also developing virus-free stock.

These developments, along with fruit-milk concentrates (p. 11, this issue), are but a minute part of a large stream of consumer benefits flowing into our lives—out of this Nation's scientific minds and laboratories. They account, in part, for the fact that American consumers now spend less than a fifth of their income after taxes for food.

These scientific minds constantly seek ways of helping consumers get more for their dollars, whether it be for food, clothing, or shelter. ARS scientists did much of the original work on wash-and-wear cotton, on stretch cotton, and on shrink-resistant wool.

Research supplies information on how to choose lumber, protect wood from decay, and improve a lawn. It provides answers to what will grow best in a garden, how to control garden insects and diseases, and how to protect against termites, ants, and roaches.

The prospective homeowner can select from 90 different house plans developed by ARS architects. And that home can be equipped with a time-and-step saving kitchen, in which the homemaker can plan and prepare nutritious meals—including, of course, strawberry shortcake.

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Orville L. Freeman, Secretary,
U.S. Department of Agriculture

B. T. Shaw, Administrator,
Agricultural Research Service

Alfalfa roots on the left have nodulation that is effective for nitrogen fixation; those on the right are ineffective.

What Causes Legume Sickness?

Researchers cite three interrelated reasons, involving soil moisture, fertility, and nitrogen fixation

■ Legume "sickness" that interferes with production of alfalfa in areas of the Pacific Northwest apparently has three interrelated causes, ARS soil scientists believe.

Preliminary research identifies these as (1) unfavorable soil moisture conditions—waterlogging in early spring and drought in midsummer—associated with dense subsoil, (2) inability of the legumes to fix nitrogen from the atmosphere, and (3) deficiency of essential mineral nutrients in the soil. Fertility deficiency apparently intensifies the effects of the other two causes.

The researchers cannot yet recommend a way of preventing legume "sickness," a condition most prevalent in east-central Washington and the Idaho Panhandle but also present in Oregon, Canada, and possibly elsewhere.

This region has grown alfalfa for a long time, but farmers have had increasing difficulty obtaining satisfactory yields for the last 15 years. Most plants appear normal the first season, but in the second year, many are spindly and chlorotic. These affected plants make little growth, and many of them die. The symptoms disappear from plants surviving to the third or fourth season.

ARS soil scientist G. M. Horner and agricultural engineer S. J. Mech are investigating the physical and fertility aspects of the soil in field experiments near Rockford, Wash. And ARS soil scientist D. F. Weber has studied the microbiological phase in the greenhouse at Prosser, Wash. Both studies are in cooperation with the Washington Agricultural Experiment Stations.

Horner and Mech found that Freeman silt loam soil at Rockford takes up about 3 inches of moisture per hour when dry. But the infiltration rate declines after 5 hours to ½ to 1 inch per hour in the topsoil and as little as $\frac{1}{1000}$ inch per hour in the subsoil. Horner explains that the subsoil, containing up to 35 percent clay, is dense and has slow permeability.

The scientists backhoed to a depth of 4 feet and deep plowed to 3 feet to break up and mix the clay subsoil with the topsoil, producing a soil with reduced density and improved permeability at depths below 18 inches. Similar treatment has reclaimed "slick spot" soils in Idaho and Oregon (AGR. Res., Dec. 1964, p. 4).

First-year alfalfa on deep-plowed soil had sufficient moisture to sustain it the entire season, but alfalfa on plots normally plowed to 6 inches suffered from moisture shortage in late summer. After deep plowing, alfalfa roots penetrated to the full depth of

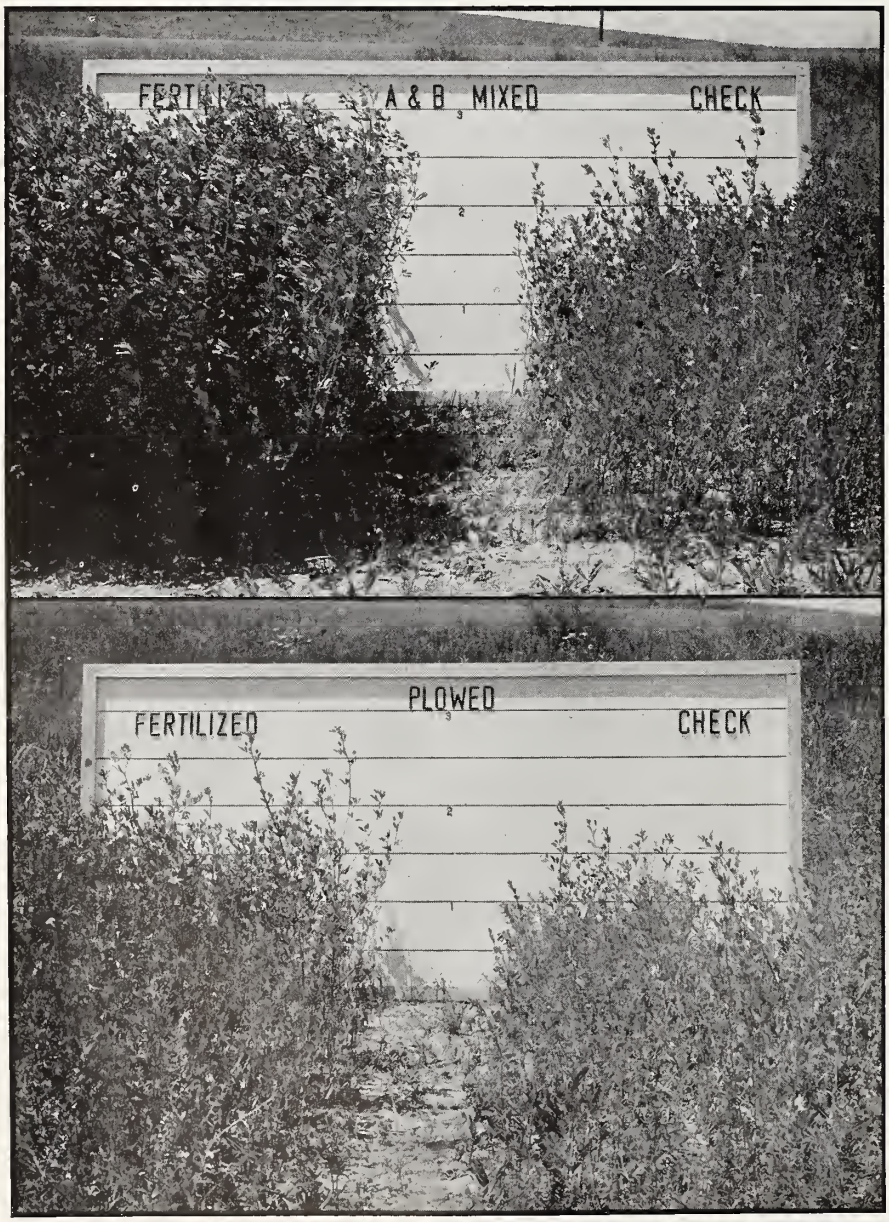
What Causes Legume Sickness?

(*Continued*)

plowing and used the moisture stored there. But few roots entered the subsoil of normally plowed plots, forcing the plants to depend primarily on moisture in the top 24 inches.

Alfalfa on conventionally plowed plots averaged 1.2 tons of hay per acre without fertilization and 1.7 tons with fertilizer. Plots where a 4-foot layer of soil was backhoed and mixed produced 2 tons of hay without fertilizer and 3 tons with fertilizer. The fertilized plots received phosphorus, sulfur, molybdenum, boron, and lime.

TOP—This alfalfa grew on soil that was loosened and mixed 4 feet deep with a backhoe. The alfalfa at left was treated with phosphorus, sulfur, boron, molybdenum, and lime. BOTTOM—The alfalfa at left received the same fertilizer treatment, but it grew on soil that was plowed to a depth of only 6 inches.



Winterkilling because of frost heaving occurred on the normal plowed plots but was not serious after backhoeing.

The studies on the failure of the legume bacteria to fix nitrogen have so far been limited to plants grown in the greenhouse. Weber has found that few of the root nodules are normal on alfalfa plants affected by legume "sickness." Nitrogen fixation cannot take place in the abnormal nodules, even though the correct type of nitrogen-fixing bacteria is supplied by inoculation.

The abnormal nodules, which lack the normal red pigmentation, are also small and misshapen, a condition the scientists have not yet been able to explain. In affected fields the number of plants with abnormal nodules may range from a few to most of the plants.

Weber produced legume "sickness" in alfalfa grown in the greenhouse under conditions that suggest it may be soil caused. For this experiment he obtained randomly selected soil samples from a number of fields in the area where the condition is prevalent. He deliberately avoided limiting the samples to lugume "sickness" sites by selecting them from bare fields whose crop history was unknown to him. He supplied all needed nutrients except nitrogen.

About a fourth of the soils produced plants that were well nodulated and made normal growth. Another fourth produced plants that were moderately affected, and the remaining half yielded plants with characteristic legume "sickness." The affected plants grew normally until they exhausted soil nitrogen. Then, because of the failure to fix nitrogen, these plants exhibited the chlorotic symptoms of nitrogen deficiency.

The field and greenhouse research is continuing.☆

Engineers connected several of the heat collectors to the same air duct, which leads to the grain storage bin (left). When not in use, the heat collectors fold up accordion like, each taking about 10 cubic feet of storage space (right).

Heat Collectors . . .

For solar-radiation grain drying

■ A portable solar-heat collector that folds like an accordion for moving and storage has provided heat that dried grain efficiently in Kansas tests.

The collapsible unit is the latest version in a series of experimental solar-heat collectors designed and tested by ARS and Kansas Agricultural Experiment Station engineers for drying grain in small bins. Besides being more efficient than previous models (Agr. Res. Nov. 1961, p. 14), it also is more durable because it can be stored when not in use.

G. R. Mowry of ARS and K. E. Robertson of the Kansas station designed the collapsible collector, which is 10 feet wide, 20 feet long, and 10 inches high—and made from inexpensive polyethylene film.

In a limited experiment, the engineers used portable units to dry 675 bushels of sorghum grain from 16.8 percent moisture content to 9.9 percent (9.9 percent is safe for long storage). Several of the portable collectors—placed side by side and connected to the same air duct (see photo)—were used to heat the air during drying. They obtained an average daily maximum air temperature rise of 27° F. for 2,800 cubic feet of air per minute.

Electricity for the fan, which operated 144 hours, cost 1.17 cents per bushel—or about half the cost of drying a similar amount of grain with conventional unheated dryers. Materials for the three solar-heat collectors used in the tests cost $35.

The top of the collector, of clear polyethylene, and the bottom, of black polyethylene, are sealed along the 20-foot sides to form an envelope. Inside the envelope, 11-gage-wire loops—they look like large coat hangers, slightly flattened and without the hook—are placed every 18 inches along the length. They hold the envelope open and pitch the top enough for rain to run off.

One end of the collector is open to admit air, and the other connects to an air duct. Air is drawn into the collector where it is solar heated; then it is drawn through the air duct to the grain bin. A 3-horsepower fan mounted in the bin draws the air from the solar collector through the grain.

Previous solar-heat collectors made of polyethylene have not weathered well. Polyethylene is sensitive to ultraviolet light, deteriorating quickly when it is exposed to intense summer sun. The newest model is more durable because it can be collapsed and stored out of the sun when not in use. Because the wire loops that support it are individually suspended, the collector collapses like an accordion and takes only about 10 cubic feet of storage space.

Mowry and Robertson improved heating efficiency about one-third by fastening a heat absorber (a sheet of black polyethylene) midway between the top of the collector and the bottom. In previous collectors, the bottom of the envelope functioned as the heat absorber. When the absorber is suspended, however, air can circulate on both sides of it, thus doubling the area of heat absorber exposed to the flow of air.☆

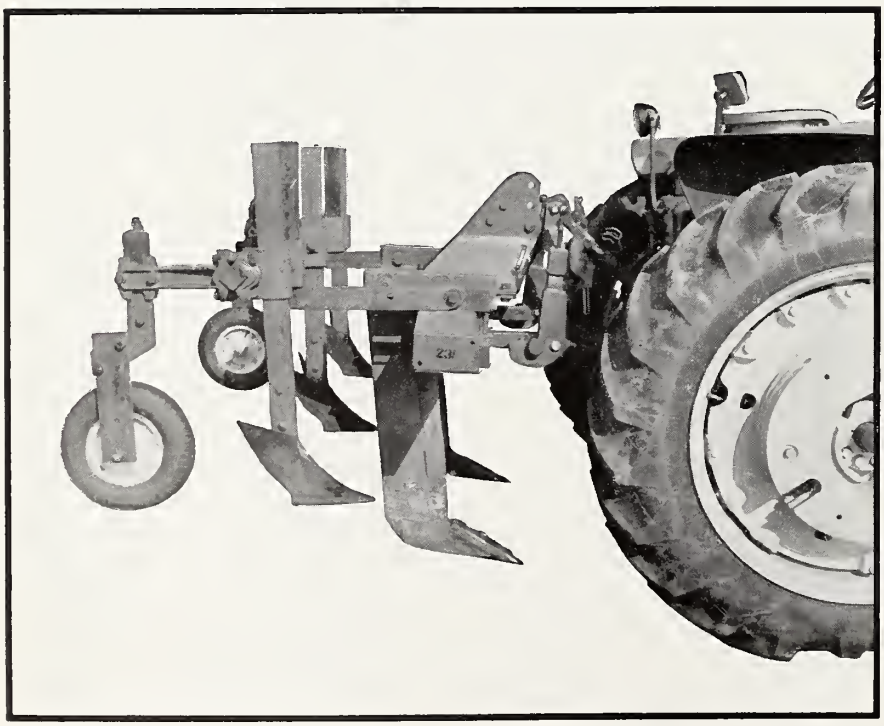
Cotton roots penetrate deeply when planting is preceded by . . .

Precision Tillage

■ A cotton plant grows taller and yields more fiber when its roots are strong and healthy. But most cotton farmers till only the upper layers of soil, leaving the root zone in a condition unfavorable for full root development.

This is the conclusion of ARS agricultural engineers at the U.S. Cotton Research Station, Shafter, Calif., where the effect of subsoil compaction on root growth is being studied. Compression and compaction of lower soil layers is becoming a serious problem in many cotton-producing regions—principally because of continuing increases in the weight of farm implements and tractors.

Precision tillage tool assembled at the Shafter station opens subsoil with two 30-inch shanks placed immediately behind the rear wheels and followed by three bedding shovels. The machine creates a deep tillage zone in close proximity to the intended drill row.



Shafter researchers have been exploring ways to break up or loosen compacted subsoil and thereby allow better root and water penetration. The most promising method yet developed is a preplanting procedure called precision tillage. Precision is required in matching the deep tillage zone as closely as possible to the row in which cotton will be planted.

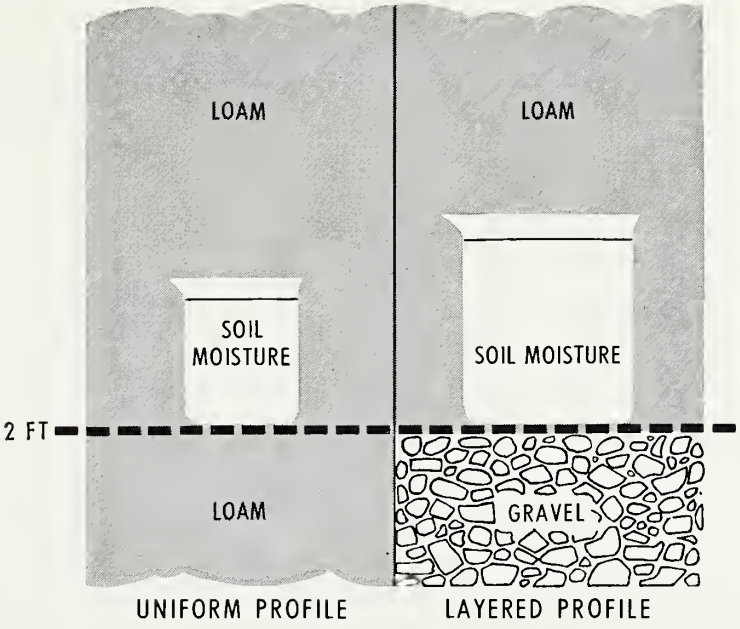
Early tests of the precision tillage method were begun in 1960, after the scientists noted that cotton was thriving when planted directly over vertical slots 20 inches deep and filled with chopped cotton stalks. Tests the following year showed that the increased growth and yield were due more to the subsoil slot itself than to the mulch material. This finding led directly to the development of precision tillage.

Later tests, in which this new method was evaluated under specific conditions, led to some conclusions:

- Precision tillage is most effective in coarse soil, which has a built in rigidity that inhibits root growth and plant development.
- There is little plant-root development below the normally plowed zone in California irrigated cotton soils. Test plots tilled to a depth of 2 feet produced taller plants and higher yields than plots either tilled to lesser depths or not tilled at all.
- Under ordinary tillage methods, plots of normally compacted soil produce higher yields than plots of artificially compacted soil. However, yields from both compacted soil types are even higher when precision tillage is used.
- A nematode-destroying agent placed at the bottom of a subsoil slot reduced root-knot damage 65 percent.
- Potassium fertilization proved more effective when used with precision tillage to increase root extension and plant growth.☆

Store 50 percent more water in . . .

Layered Soil



■ A uniform soil underlain by coarse sand or gravel can store more water than a similar soil without the layer of coarse material, research indicates.

ARS soil scientist D. E. Miller found that a uniform soil above a layer of coarse sand or gravel holds about 50 to 60 percent more available water than similar soil of the same depth without such a layer. The research, conducted at Prosser, Wash., was cooperative with the Washington Agricultural Experiment Stations.

The soils of many irrigated areas of the West are layered because they were deposited by flowing water that carried sand or gravel—or because they were deposited on top of coarse water-lain materials. The coarse-textured material increases the efficient use of irrigation water by limiting moisture loss through deep percolation in these soils.

Moisture held in the soil is under suction or tension, Miller explains—the smaller the amount of water, the greater the suction. The coarse layers contain mostly large pores that drain readily after the soil has been wetted, while the smaller pores in the overlying soil remain water filled. Because of the many empty pores in the coarse layer, resistance to water movement through the layer becomes so great that water cannot drain out of the soil layer above. It is thus available for plant use.

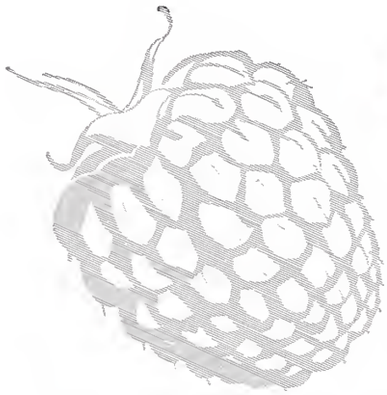
Miller compared layered and uniform soils in artificial profiles constructed by digging pits and refilling them with layers of either sand or gravel and layers of uniform sandy loam, or with uniform loam only. The 8- by 10-foot pits were 5 feet deep. He irrigated the profiles and covered them with plastic and straw to prevent evaporation.

A week later, the layered profile had retained 50 percent more moisture than the uniform soil profile. This additional moisture was still in the layered profile after 2 months, while moisture continued to drain from the uniform soil. After 2 months, the layered soil had 8.1 inches of water in the upper 2 feet, compared with 4.7 inches in the uniform soil.

Miller also found that usual procedures for measuring or predicting the water-holding capacity of irrigated soils—designed for use in uniform soil—may seriously underestimate moisture storage in layered soils. Available moisture measured in the field was 130 percent greater than the laboratory estimate for Ephrata and Timmerman soils and 104 percent greater than the laboratory estimate for Rupert soil.

Field determinations in stratified soils can also be in error if precautions are not taken to prevent lateral movement of water from the point of measurement. In the process of minimizing deep percolation, the coarse layer tends to cause water movement across the top of the layer. Where lateral flow was permitted, the available water measured at a depth of 6 to 12 inches in Ephrata and Scooteney soils was only 60 percent as much as that recorded where lateral flow was prevented.

As an outcome of this research, Miller is investigating what promises to be an improved procedure for measuring the water-holding capacity of layered soils. It is based on the water-losing (desorption) characteristics of the soil and the moisture conductivity of the underlying coarse materials in an unsaturated condition.☆



Research Improves Ou

Detecting Hidden Virus

■ A technique has been developed for detecting two mosaic viruses which commonly infect red raspberry plants without producing the usual symptoms of disease. This could lead to virus-free planting stocks that would rejuvenate raspberry production in the Eastern United States.

Current research on raspberries parallels achievements in the 1950s with strawberries, which were also infested with viruses. ARS scientists turned up virus-free plants of 34 strawberry varieties, the basis for virus-free planting stock.

The technique, perfected by ARS plant pathologist R. H. Converse, permits screening of raspberry plants for the presence of the two diseases, heat-labile mosaic components (HLMC) and Rubus yellow-net virus (RYNV).

Three leaflets from raspberry plants being examined are grafted into the petioles of *Rubus henryi*, a test plant extremely sensitive to the viruses. The grafted plants are held 14 days under intermittent mist, followed by 21 days in the greenhouse. If leaflets from diseased plants are used—even if the disease is only latent in them—virus will be transmitted and symptoms will develop in the *R. henryi* test plants.

More important, if *R. henryi* fails to become infected, it means that the raspberry plants from which the leaves were taken are "clean" of the two viruses. The leaf-graft method is 95 percent accurate as an indicator of the presence or absence of the diseases.

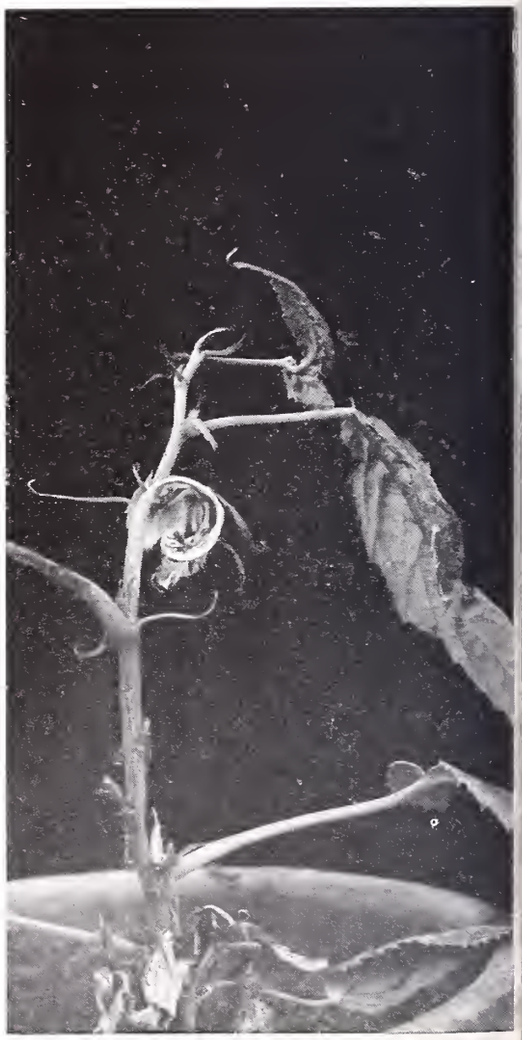
The method works on all brambles, although Latham raspberries were used in the tests at Beltsville. Approximately 80 to 90 percent of all raspberries grown in the East are Latham, and all are commonly infected by the viruses.

Nearly all commercial plantings of Latham are infected with HLMC, which alone can cut raspberry stands and yields in half. About half of these plantings are also infected with RYNV, creating an even more destructive disease complex.

High temperature treatments, virtually a laboratory operation, can inactivate HLMC in diseased plants. However, because the mosaic viruses are latent, an accurate screening method is needed to make certain that even heat-treated plants are free of the viruses.

Heretofore, the viruses were detected by a laboratory procedure that involved the use of aphids, which are natural transmitters of HLMC and RYNV. Although the aphid method is quicker than leaf grafting, it is only 20 to 50 percent accurate.

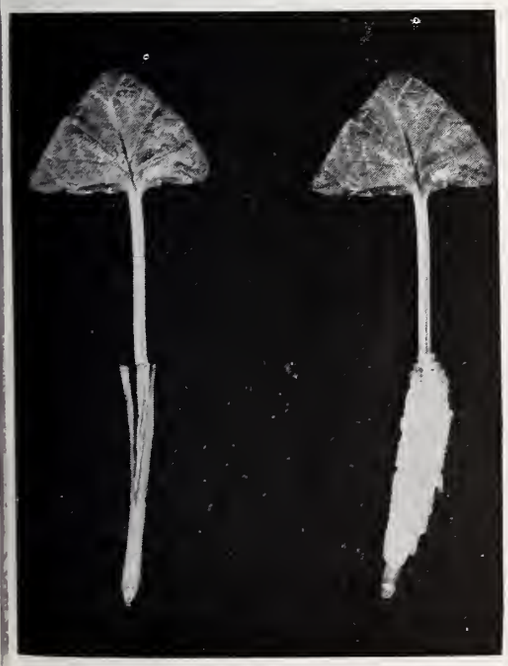
Agricultural agencies in about 10 States are now beginning to employ the new screening method. In years to come, as "clean" stock is identified and increased, it may be possible for a grower to plant a cash crop of raspberries—without cutting his estimated profit in half.☆



ook for Raspberry Production

The effect HLMC has on R. Henryi *is seen by comparing the healthy plant (A) with infected plant (B) and dead plant (C).*

BELOW—New method of detecting mosaic virus involves grafting leaflets of plants being examined into the petiole of R. Henryi, *a virus-sensitive plant. Leaflets show graft before (right) and after latex wrapping had been removed.*



Developing Virus-Free Stock

■ Raspberry plants propagated from stocks that are free of mosaic viruses can, with conventional insect control procedures, remain relatively free from reinfection in the field for 2 years or more. This is a considerably longer period than ARS researchers had anticipated.

The researchers report that stocks of 17 varieties of mosaic-free raspberries were introduced into commercial channels in 1964—more than twice the mosaic-free varieties released over the previous 3 years.

Mosaic viruses, so-called because they create a mosaic design on leaves, are widespread in the United States. They cause serious reductions—often 50 percent or more—in yield and stand. As a result, fewer farmers have attempted raspberry production in recent years.

To rehabilitate the raspberry industry by helping farmers increase quality and yield, ARS in cooperation with Canadian researchers developed mosaic-free stocks of many commercial raspberries. These have been released into commercial channels.

Nursery sources of these stocks are required for establishing new plantings because reinfection in the field is common. The recent field tests were conducted to determine how long mosaic-free stock could be grown in commercial planting before becoming reinfected. Only 3.3 percent of the plants became reinfected over a 2-year period at 14 field locations in 9 Eastern States. The rate ranged at various locations from 0 to 7.1 percent; no reinfection occurred at 9 of the 14 locations.

Researchers found no geographic trend in these percentages, but they did find that certain varieties seemed to display greater susceptibility to mosaic-virus infection than others. Sunrise, Milton, Canby, and Dundee showed greatest rates of infection under the varying conditions of the tests. Latham and Cuthbert were not reinfected.

Commercial growers who plant "clean" material can expect the stocks to remain relatively free of mosaic viruses for several years, particularly if plants are sprayed to control aphids, which act as virus vectors, and if some isolation from unsprayed plants is maintained.

USDA has released indexed stocks of the varieties of black, purple, and red raspberries listed below. The number after the variety name indicates the year in which the variety was indexed and stocks found free of all known viruses.

Black raspberries: Black Hawk–64, Bristol–64, Cumberland–64, Dundee–61, Morrison–64, Plum Farmer–62, Shuttleworth–64.

Purple raspberries: Clyde–64, Marion–64, Sodus–64, Success–64.

Red raspberries: Amber–64, Canby–62, Cuthbert–64, Fairview–64, Latham–62, Marcy–64, New Hampshire–64, Newburgh–61, Puyallup–64, September–64, Sunrise–62, Taylor–62, Viking–64, Washington–62.☆

Double-Duty Crop

Black locusts convert wasteland, provide income from fence posts

■ Erosion-control and reforestation research has shown how Appalachia farmers can grow black locust trees to get income from steep, eroded land.

Black locust trees make a cash crop: fence posts. These posts are preferred by many farmers because they outlast other wooden fence posts. But just as important on steep slopes, the trees build up the soil with their roots and leaf litter—increasing absorption and reducing runoff and erosion. As legumes, black locust also improve the soil by adding nitrogen taken from the atmosphere.

Twenty-five years ago, scientists of ARS and the Ohio Agricultural Experiment Station planted black locust trees at the North Appalachian Experimental Watershed, Coshocton, Ohio. They planted 1-year-old seedlings in two 1-acre plantings on eroded and gullied land, setting the trees 6 feet apart (about 1,200 per acre).

Ten years after the trees were planted, the two 1-acre plantings were subdivided into ¼-acre plots, and each winter for eight winters one ¼-acre plot was cut for fence posts.

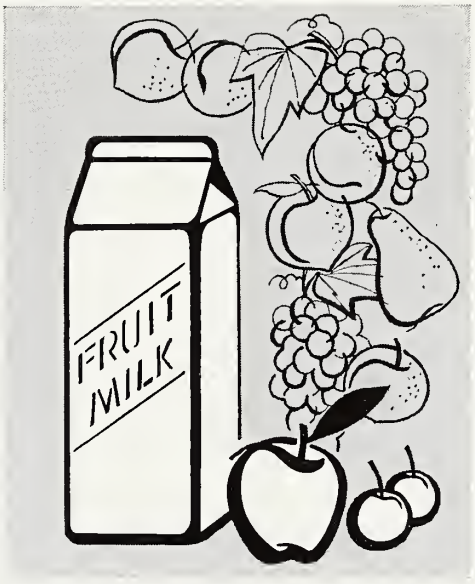
The trees were cut close to the ground, at a slight angle, so that water would not soak into and rot the stumps. Brush and weeds on the plot were also cut so they would not shade the stumps. A few months after the trees were cut, the stumps sprouted, and each stump produced several rapidly growing sprouts.

Trees that developed from the sprouts were harvested 13 years after the first cutting had been made.

Trunks of the trees were cut into 7- and 5-foot fence posts. First-cutting posts had a market value of $400 per acre—an average of $40 per acre for each year of growth. Posts from the second cutting were worth $624 per acre—an average of $48 per acre for each year of growth.

The initial cost of the trees is small—about a penny a tree. Planting and cutting can be done during slack seasons.☆

First-cutting black locusts were cut close to the ground, at a slight angle, so that water would not soak into and rot the stumps. Each stump produced several sprouts, which then grew into second-cutting trees.



Fruit-Milk Concentrates

They're stabilized naturally with apple or quince pulp

■ Something unexpected happened during research in Italy on the stabilization of concentrated mixtures of milk and fruit juice.

As a result, completely natural fruit-milk concentrates were produced, for the first time, without commercial additives as stabilizers.

Under an ARS-awarded grant, scientists at the Milan Experimental Station for Refrigeration were performing a series of experiments aimed, among other things, at developing a mixture of milk and fruit pulps that could be quickly restored with water to make drinks with fresh-fruit taste.

The first need in developing such a mixture was stabilization of the casein in milk to keep the milk from coagulating when fruit pulps were added in amounts needed to dominate flavor.

While the Italian scientists studied ways to improve on accepted methods of stabilization—in order to have a higher proportion of milk in the concentrate, they also mixed fruit pulps with milk to determine just how much of each fruit pulp had to be added before the milk coagulated.

This is when something unexpected happened. Apple and quince pulps didn't cause the milk to coagulate at the low concentration points of other fruits. The scientists reasoned that the pectin of these fruits stabilized the casein in the milk.

So, along with their planned experiments on using smaller amounts of additives to stabilize the mixtures, the scientists studied the possibility of replacing these additives with apple or quince pulp.

They performed numerous experiments with quince or apple pulp in combination with other fruit pulps. The aim was to add these pulps in small enough quantities that they would act only as stabilizers, allowing the product to have the taste, color, and odor of another added fruit.

The results were good. Apple and quince pulps gave complete stabilization in many combinations with many different fruits. For example, a stable product that tasted like grape juice was obtained by mixing 0.62 parts of grape pulp, 0.4 parts of apple pulp, and 1 part of skim milk. And a drink with peach flavor was obtained by mixing 0.3 parts quince pulp, 0.95 parts peach pulp, and 1 part of milk. Apple pulp mixed with equal parts of peach and pear pulp produced a product that was highly praised by taste panels.

In all these mixes, a high percentage of milk can be used. Thus the mixes, whether used to make beverages or as additions to baby foods, have a fresh-fruit taste, the nutrients of skim milk, and good keeping qualities.

In their numerous experiments with the natural fruit stabilizers and the additives, the scientists at the Milan station tried whole milk, skim milk, and powdered milk; fresh pulp, canned pulp, and frozen pulp. In general, they found skim milk and fresh pulp most satisfactory. The apple and quince products were made with canned pulp and skim milk.

This research was financed by foreign currencies received by the United States from the sale of U.S. surplus agricultural products under Public Law 480. These foreign currencies cannot be converted into dollars for use in the United States, but part of them can be used to pay for foreign research benefiting U.S. agriculture.☆

Plant pathologist finds that cyst nematodes open the door to . . .

Fusarium Wilt in Soybeans

■ Soybean cyst nematodes "open the door" in soybean roots for the fungus organisms that cause fusarium wilt, an ARS plant pathologist has found.

J. P. Ross revealed the relationship between the nematode and fungus diseases in research conducted jointly with the North Carolina Agricultural Experiment Station at Raleigh.

Although the nematode-fungus combination has not affected soybeans on a large scale, the fact that most of the widely grown soybean varieties are susceptible to infestation by cyst nematodes means a potentially serious economic threat exists. And basic knowledge of this relationship could be helpful also in diagnosing similar damage to other crops.

Ross experimented with three soybean varieties—Jackson, Lee, and Yelredo—each having a reaction to nematodes that was already known. Beginning with greenhouse experiments, Ross grew Jackson plants in two batches of soil, one batch containing soybean cyst nematodes and the other free of nematodes. He then added fusarium wilt organisms to both of the batches. Only plants growing in the soil containing both the cyst nematodes and the wilt organism showed fusarium wilt symptoms.

Ross then expanded the scope of the investigations on small outdoor plots to determine whether root-knot nematodes as well as cyst nematodes open the door to fusarium wilt in soybeans. Besides the Jackson variety, he used Lee, which is highly susceptible to both cyst and root-knot nematodes, and Yelredo, which is highly susceptible to fusarium wilt.

These tests confirmed the greenhouse finding that the cyst nematodes do open the way to the fungus infection in soybeans, although different soybean varieties react differently to the nematode-fungus combination. The root-knot nematode (*Meloidogyne incognita*) had a similar effect—but not to the extent that the cyst nematode did.

Other findings of interest:

- In tests involving Lee, wilt symptoms appeared most frequently in plots infested with cyst nematodes and fusarium—and less frequently in plots infested with root-knot nematodes and the fungus. No symptoms appeared on plants in control plots or in plots infested with nematodes only. And nematode populations were higher in plots with fusarium.
- All Yelredo plants in plots infested with both cyst nematodes and fusarium died within 16 weeks after planting. Most plants in plots infested with the fungus alone survived but showed wilt symptoms.
- When Jackson plants were exposed to root-knot nematodes and fusarium, all remained free of wilt symptoms.

Ross believes the different types of damage done by the cyst and root-knot nematodes account for the fact that cyst nematodes more effectively open the way for fusarium wilt infections. Root-knot nematodes usually invade the root-tip regions and cause only slight cell destruction. Cyst nematodes, on the other hand, attack more mature roots and cause more extensive cell damage. Since the wounds opened by root-knot nematodes close more rapidly, there is less opportunity for the fungus organisms to enter.☆

Jackson soybeans that were exposed only to the cyst nematode (A) or only to fusarium wilt (B) are relatively free of wilt symptoms. Plants that were exposed to both of the pathogens (C), on the other hand, are wilted or distorted.

Legumes Versus Nematode

Nematologist, agronomist compare five legumes in rotation with sugarbeets

■ When crops that are not attacked by the sugarbeet cyst nematode are rotated with sugarbeets, the nematode population declines and growers can produce sugarbeets on the same land once in 3 years.

This is why growers rely on crop rotation to control nematode populations in their beet fields. Although no nematode-resistant sugarbeets are now available, researchers recently announced experimental lines of sugarbeets that show excellent defense against cyst nematodes and root rot (see AGR. RES., October 1964, p. 12).

Roots of certain nonhost plants secrete materials that stimulate both the hatching of nematode eggs and the emergence of larvae from protective cysts. Larvae invade the plant roots but cannot develop and reproduce.

Scientists are seeking rotation crops that will do the best job of reducing the numbers of viable eggs and infective nematode larvae in the soil. ARS nematologist A. E. Steele and research agronomist Charles Price, cooperating with the Beet Sugar Development Foundation, tested 5 legumes in rotations with sugarbeets on nematode-infested plots. The tests were conducted at the U.S. Agricultural Research Station, Salinas, Calif.

The researchers found that Chilean alfalfa is particularly effective as a rotation crop. They also studied Kentucky Wonder white-seeded pole beans, California small white beans, Alderman peas, and White Dutch clover for their effect on nematodes.

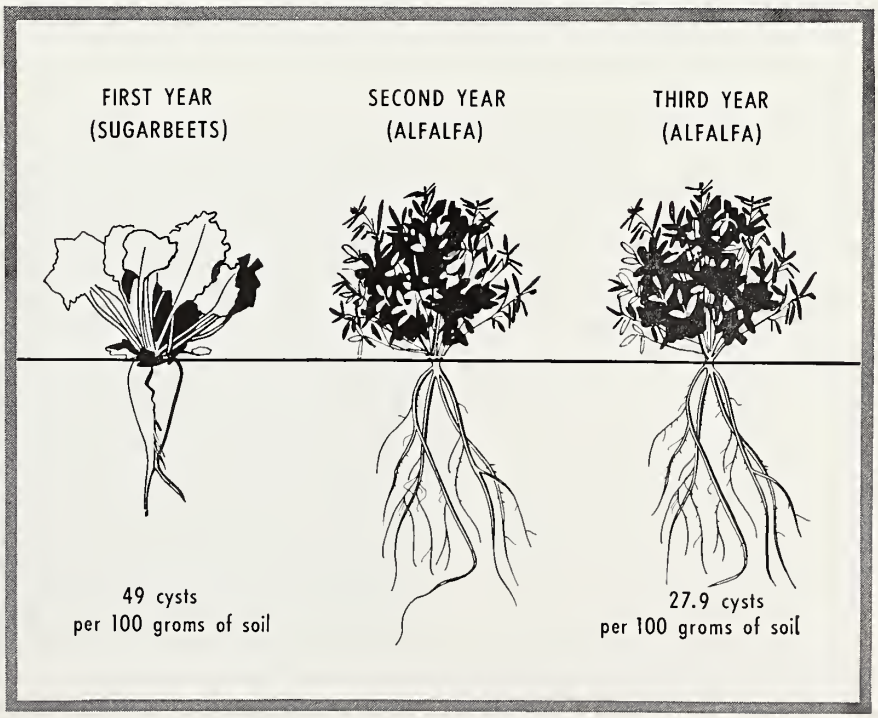
Alfalfa and clover reduced larvae populations considerably more than beans or peas. Alfalfa, in fact, was almost 2½ times as effective as the California small white bean and nearly 3 times as effective as the peas and pole beans. Clover was about three-fourths as effective as alfalfa.

In the tests, beets were started in sterilized soil in the greenhouse and transplanted to small nematode-free plots (microplots). The scientists then added nematode-infested soil to each plot. Nearly a year later they took soil samples from the plots, after the beets had been removed, and counted the nematode cysts, which averaged 49 per 100 grams of soil.

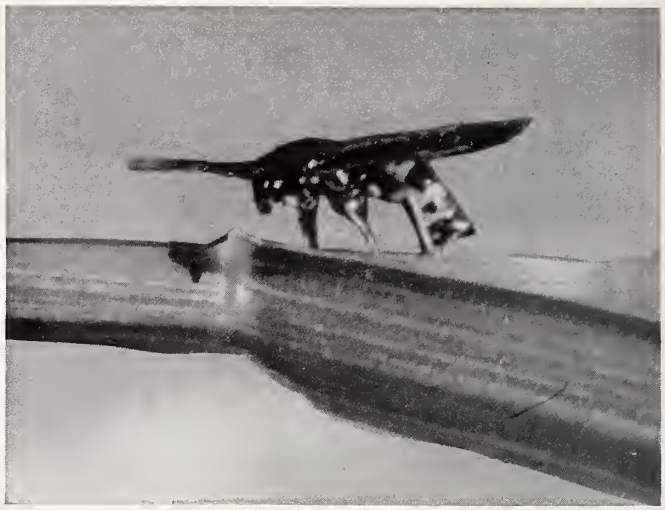
For the next 2 years legumes were grown in the plots, and each autumn researchers again took soil samples and counted the cysts present. The number of cysts averaged 27.9 per 100-gram of soil sample—which was a decline of about 43 percent during the 2-year period.

Sugarbeets were again planted in the soil after two seasons of legumes. Researchers found that fewer nematode larvae developed on the roots of sugarbeets in some soil plots than in others—depending on which legume crop had been grown.

As a result of these tests, ARS scientists see alfalfa as a highly valuable crop for use in rotations with sugarbeets in soil infested with the sugarbeet cyst nematode.☆



The wheat stem sawfly, which poses a threat to wheat, rye, and related grasses, cuts an incision around the inside of the stem, thus causing weakening and breakage.



Biological control of . . .

THE SAWFLY

Two parasitic enemies of wheat stem sawfly have become established

■ The use of parasites or predators—to attack and destroy harmful insect pests—has been under study by ARS researchers for many years. This biological method has been successful, for example, in reducing populations of the alfalfa weevil, the citrus blackfly, and the European corn borer.

Present indications are that it might also be successful in reducing sawfly damage to wheat, rye, and related grasses.

This damage begins late in the spring when female sawflies deposit their eggs inside the grain stems. Upon emerging from the egg, each larva tunnels downward through the stem, feeding until it approaches the base of the plant. It then cuts an incision around the inside of the stem, plugs itself off below the incision, and spins a thin cocoon in which it spends the winter as a full-grown larva. Stems with these incisions are so weakened that they often break, and the grain from the effected plants is missed by the harvester.

Although sawflies were found in the United States as early as 1887, it was not until the mid-1930's that they began to cause serious damage. In 1935, USDA scientists initiated a program to reduce this damage by introducing a parasitic insect that had been tested in the Canadian prairie provinces 5 years earlier.

Large numbers of *Collyria calcitrator*, a wasp species which parasitizes by depositing its eggs in sawfly larvae, were imported from Europe and released in Pennsylvania, Ohio, and New York over a 4-year period. After collecting and examining sawfly larvae, following these releases, the researchers concluded that the parasite had not succeeded in establishing itself.

The Canadian Department of Agriculture made several releases of *C. calcitrator* from 1937 to 1940 and succeeded in establishing it in southern Ontario.

In 1957, 22 years after its first release in the United States, *C. calcitrator* was found to be firmly established in areas of New Jersey and Pennsylvania. This led to an extensive USDA survey of wheat fields from New England south to North Carolina and west to Indiana.

The survey revealed that *two* wasp parasites had successfully established themselves in the Northeastern States. Besides the widely dispersed *C. calcitrator*, a second wasp species, *Pediobius nigritarsis*—probably also a native of Europe—had greatly increased in number. For the most part, each of these wasps parasitizes a different sawfly species.

Survey results also indicate that *C. calcitrator* has been established in at least six of the Northeastern States for many years. It is not clear, however, whether this establishment resulted from the USDA releases or from the releases made in Canada. Since this parasite produces only one brood a year, it is unlikely that it could have dispersed from Canada to its present geographic range in the 25 generations since it was released there.

The full story of *C. calcitrator's* value as a biological control agent is still to be determined. The species of sawfly that it attacks has declined in numbers in recent years, but populations of other sawfly species have also declined. Further research on this entire parasite-host complex is necessary to clarify the survey findings.☆

Peeled wheat is creamy white

A low-cost new process has been developed by ARS that removes the dark bran from wheat and other cereals, leaving clean, creamy-white whole grains. The product retains all the endosperm—including the nutritious aleurone layer.

This new peeling process opens the way to bulgur that is nearly white and to lighter color in other foods that include whole or cracked cereals.

The light-colored wheat product has a good commercial potential not only in domestic markets but also overseas, especially in countries where regular bulgur is not yet well accepted because of its color and bran content. Several processors are already conducting developmental studies with the USDA process.

Even without the new debranning process, U.S. export of bulgur has risen sevenfold—from 60 million pounds in fiscal 1962, the first year it was exported, to 420 million pounds in fiscal 1964.

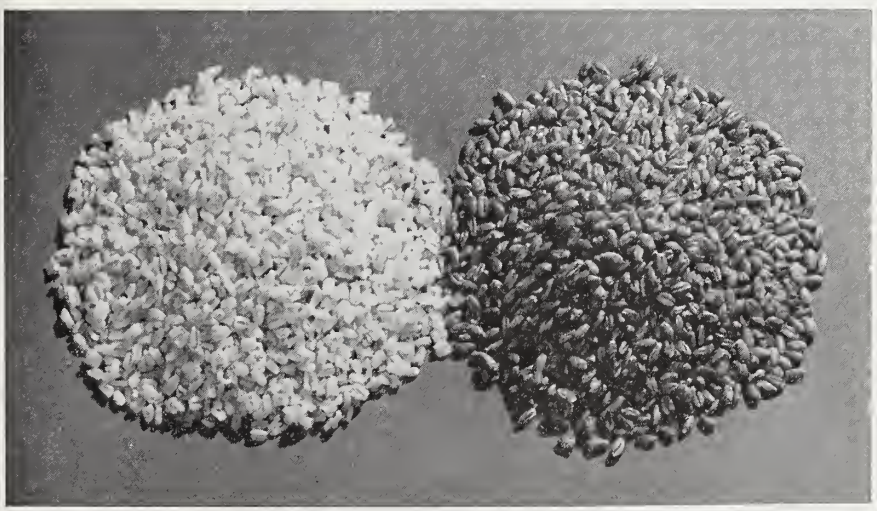
ARS chemical engineers A. I. Morgan, E. J. Barta, and P. W. Kilpatrick developed the debranning process at the Western utilization research laboratory at Albany, Calif. The work is part of a broad effort by ARS to increase the usefulness of cereals in products consumed here and abroad.

The scientists at Albany say the process makes a clean break between the outer bran and the aleurone layer of the wheat kernels. A warm 20-percent-lye solution is applied to the kernels in a mixer, using only enough of the solution to wet the kernels. The lye-treated grains then fall into water and are pumped through small orifices. This turbulent action removes most of the lye and separates the bran, which rises and floats away from the grain. Then a weak acetic acid solution neutralizes lye remaining on the debranned kernels and brightens their color.

Since this peeling process removes only the bran, it is more efficient than pearling, the commonly used abrasion process which removes outer coats of the grain, including a portion of the endosperm. Because of this abrasion, pearled kernels are nearly round.

In the manufacture of debranned bulgur, the wheat is first mildly parboiled. Then the hot, moist wheat kernels are debranned or peeled—and dried. The resulting light-colored bulgur can be served alone after steaming or other heating for 15 minutes, or it can be used in many recipes.

Oats and barley can be peeled by the same chemical process. These peeled grains, not so nearly white as those of wheat, can be milled to flour or used in other ways.



Wheat that was parboiled and then peeled by the new process is creamy white (left) compared with raw wheat (right).

Drylot lambs are parasite free

Proper flock management can lead to parasite-free lambs in humid areas of the United States where internal parasites are often a serious problem.

Experiments conducted at the Agricultural Research Center, Beltsville, Md., by ARS parasitologists and sheep husbandmen show that lambs raised in drylot are essentially free of internal parasites while lambs raised on pasture become infected with worms.

Lambs born in 1959–61 were divided into three groups for the experiment. The first group was kept in drylot. During weaning, the dams were allowed to graze from early afternoon until the next morning, then returned to their lambs. These lambs showed no signs of parasitism throughout the experimental period.

The second group was raised on pastures not previously grazed and was moved to new pastures every 2 weeks throughout the grazing season. These lambs did not become parasitized until late in August, when old enough to withstand infections.

The third group was kept on previously grazed pastures and was moved

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from pasture to pasture only when forage became scarce. A similar system had been used at Beltsville before 1959. By June, these lambs had become heavily parasitized.

All lambs on pasture were fed pellets until weaned. Throughout the test period, the drylot lambs were given pellets and were also allowed one-half pound of hay per day. Ewes and lambs in each group were given continuous access to a phenothiazine-mineral mixture from the beginning of the grazing season.

Sheep used in these experiments included Merino, Targhee, Hampshire, Shropshire, Southdown, and crossbreds representing two-, three-, or four-way crosses.

Fiberneer boxes stand up well

A new packaging material called Fiberneer has been developed by the Forest Service at its Forest Products Laboratory at Madison, Wis., in cooperation with the U.S. Air Force.

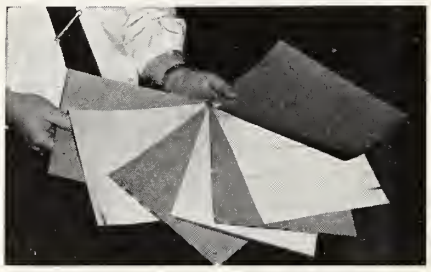
It shows promise as a lightweight, moisture-resistant container material with excellent stacking strength.

The new material resembles single-wall corrugated container board. It consists of two sheets of wood veneer, each faced front and back with extensible kraft paper; these two laminations, in turn, are glued sandwichlike to a corrugated sheet.

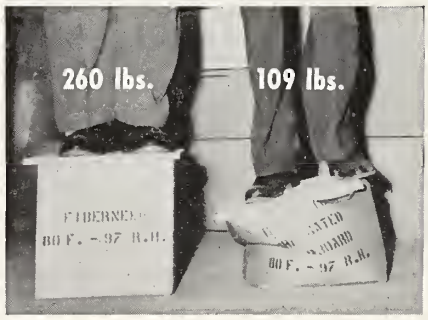
Pilot experiments at commercial board mills indicate that the new material can be made on high-speed machinery and scored for future folding into boxes.

Fiberneer's remarkable top-to-bottom compressive strength approaches that of triple-wall material, but it is lighter and only half as thick. Performance superior to that of conventional corrugated fiberboard was obtained experimentally under conditions of high humidity.

Boxes made of Fiberneer are being evaluated for resistance to rough handling and for compressive strength after storage in a normal dry atmosphere and a highly humid one—and after immersion in water.



New container material consists of seven thicknesses: Two wood veneer, four kraft paper, and one corrugated. Superior stacking strength of the Fiberneer is shown below.



Oral drug removes sheep tapeworm

A new oral medication—bithionol—has proved effective in removing the fringed tapeworm from sheep. This tapeworm (*Thysanosoma actinioides*) is a prevalent sheep parasite on western ranges, where it is responsible for more than half a million dollars in sheep liver damage per year.

ARS parasitologists have tested many compounds for control of this parasite. The only effective compound was bithionol, given as an oral dosage of about 1/28 of an ounce for every 10 pounds of body weight (220 milligrams for each kilogram of body weight).

In one test, 24 sheep infected with fringed tapeworm were given bithionol, and only 4 of these had fringed tapeworms when slaughtered several weeks later. In contrast, 19 out of 21 infected but untreated sheep were heavily parasitized.

The fringed tapeworm invades the small intestine and main bile ducts of the liver. The ducts become enlarged and inflamed, making the liver unfit for human food. More than two million sheep livers are condemned by meat inspectors each year because of this parasite.

The life history of the fringed tapeworm is still being studied. Scientists think that an insect or other small animal acts as an intermediate host because attempts to transmit the parasite from sheep to sheep have been unsuccessful.

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